TM-944
2817.000

Fermilab

A DIGITAL MEASUREMENT SYSTEM FOR SENSING MAGNET CURRENT AND INTERLOCKING MEASURED LEVELS INTO SAFETY SYSTEMS

Daniel P. Schoo
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1. Introduction

In the past, for reasons of radiation safety, it has been necessary to monitor operating current levels in certain magnets and cause safety systems to react to levels that fall beyond predetermined limits. Traditionally this has been done by measuring the current with a shunt/meter relay system. Dual set points on the meter relay allowed the use of upper and lower limits. This system was found to have several inherent disadvantages. The meters had to be installed in equipment racks, sometimes far distant from the power supply controlling the current. Shunt leads having high voltage present had to be strung over a long distance. Mechanical movements sometimes became unreliable, sticking in one position until tapping the meter face caused deflection. Current limits were easily reset inadvertantly.

2. Specification

For these reasons and others, a new system was designed using the following criteria. The system must reside in the power supply controlling the current. It must be completely electronic. It must be easy to set the limits deliberately; but very difficult to set inadvertently. It must have the present current level displayed in a manner easy to read. It must be redundant for safety.

It must indicate a trip condition. An indication that the unit is functioning would be desirable.

The final version of the system met all of the specified requirements. The unit is mounted in a double width NIM module and is intended for use in a slot in a transrex power supply normally occupied by an external reference interface module. For this reason the interface electronics is included in the same module.

3. Implementation

Two independent systems are used for redundant protection from failure. Each one uses an isolated operational amplifier for isolation of the buss from other circuitry. The output of this OP-AMP is converted to a digital number by a dual slope integrating analog to digital converter chip set. Because the data from the A/D converter is multiplexed, a set of latches retains the two most significant digits of the data. These two digits normally correspond to the thousands and hundreds digits when used in a transrex supply. All four digits are displayed on the front of the module for channel A only. The two most significant digits are compared by two comparators; one looking for a less than setting condition, the other looking for a not less than setting condition. The setting values are programmed in with rotary dip switches mounted on the circuit board. The comparator outputs are buffered by driver chips that actuate relays to interface to external circuitry. In total, two high level and two low level settings are provided and are independently adjustable in one hundred amp intervals from zero to 9900 amps. Light emitting diodes are provided on the front panel to indicate trips and to show sampling of the A/D converters. As an added feature, the sampling can be placed in a trigger mode with a front panel switch. A Lemo connector is provided for each channel to accept trigger pulses. The pulses accepted are standard 1 microsecond, 5 volt positive true, terminated into 50 OHMS. In the trigger mode, on

receipt of a pulse, one sample is taken and held until the next pulse is received. It should be pointed out that the trigger mode should be used only for non safety related applications unless redundant trigger pulses are available.

4. Conclusion

After initial tests, the digital current comparator module has proved to be a great improvement over previous systems. Its versatility and ease of modification to suit special applications has already been exploited. From measurements made during bench testing, the accuracy has been comparable to that of a Hewlett-Packard 3465A digital multimeter.

Although the module was designed to measure current using a shunt, any voltage that can be scaled to a convenient range can be monitored. It has already been suggested as a means of monitoring the voltage produced on the safety leads of a cryogenic bending magnet system. Other applications will no doubt be found.

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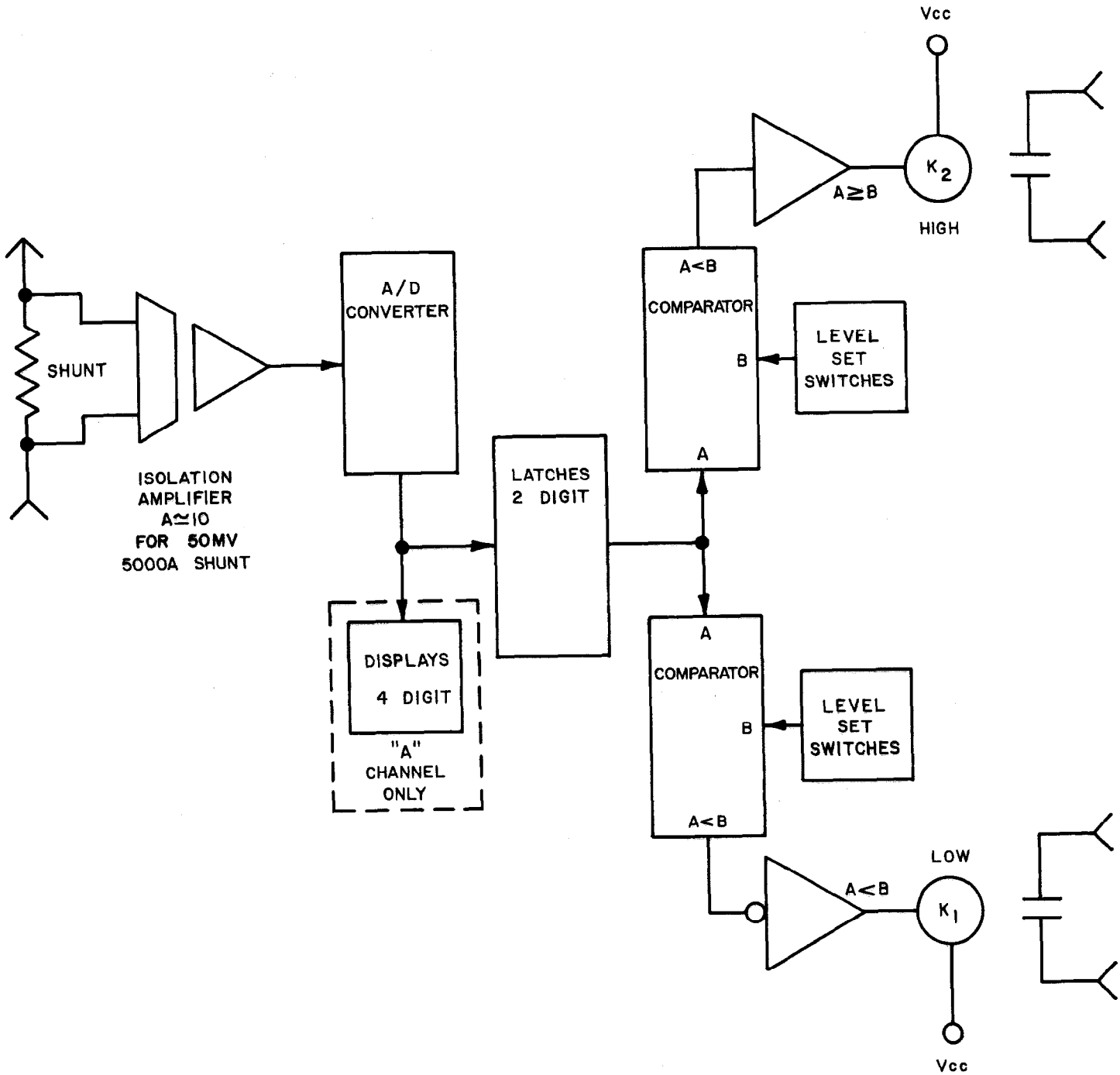
DIGITAL CURRENT MONITOR
BLOCK DIAGRAM
(ONE CHANNEL SHOWN)



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